INTENSITY DISTRIBUTION IN THE ECHO-2 SPECTRUM

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ABSTRACT: Curves were determined which characterize spectral features of the photographic system used for artificial satellites observations. The comparison of similar curves shows a satisfactory coincidence of the intensity distribution in the satellite spectrum and in the solar continuous spectrum.

Spectrographic studies of bright satellites were conducted at Station No. 1073 of the Odessa Astronomical Observatory in 1965-1966. /11* A meteor spectrosensitometer were designed and built in the observatory for the photometric calibration and standardization of the images of short-duration light phenomena. This instrument makes it possible to obtain a set of calibrations both for meteor exposures, as well as for exposures corresponding to the daily movement of the stars. The intensities of the satellite images, obtained from the sensitometer scale or from the stellar photometric scale, are distorted because of the spectral properties of the photographic system and the photometric error of the field of the NAFA-3s/25 camera. The influence of the spectral properties of the system is a combination of three factors: the spectral transmittance of the atmosphere, the camera optics and the spectral sensitivity of the panchromatic film receptor.

The spectral sensitivity of the film can be determined with an ISP-73 /12 spectrosensitometer. The spectral transmittance of the "Uran-9" objectives can also be determined photographically with the aid of the ISP-73. Spectrograms, obtained with the ISP-73 with and without the camera optics, were compared to determine the transmittance of the objectives. As it turned out, the transmittance of the optics starts to decrease from about 5500 Å. The sky transmission was determined with the aid of photoelectric photometers.

The total curve, characterizing the spectral properties of the system, has a pronounced maximum in the vicinity of 6500 Å as the result of the interaction of all these factors. The curve has a second maximum in the vicinity of 4700 Å because of the increase in the spectral sensitivity of the aerial photographic film in the blue portion of the spectrum.

A special apparatus was designed and built to investigate the photometric error of the camera field. A detailed description of the apparatus is given in [1]. A description of the meteor spectrosensitometer is also given there. The optical system of the apparatus, designed for determining the photometric error of the field, allows the ray path from a celestial object to be simulated under laboratory conditions. As the camera under test is turned to different orientations around the circumference of the ring-shaped holder of the support, a series of fringes, produced by the light source and intersecting at the optical center, is obtained on the photographic film. The nature of the optical density variations, in different directions, as a function of distance from the optical center can be determined from photometric measurements of the fringes.

*Numbers in the margin indicate pagination in the foreign text.

Optical density measurements show that the isodensity curves are circularly symmetrical with respect to the optical center. The variation of the optical density as a function of distance from the optical center of the focal plane of one of the cameras is shown in Fig. 1. For comparison purposes the optical density at the center of the format was assumed equal to zero. The circles in the figure represent regions of uniform optical density. Some of the directions of light source motion, producing the fringes, are indicated by the arrows. Each division /13 denoted on the horizontal arrow represents a distance of 10 mm. The maximum optical density, as seen from the figure, is obtained at a distance of 35 mm from the optical center for the specific camera represented in Fig. 1. The region of best focus occurs at this distance. Possible differences in the nature of the field error as a function of the radiation wavelength of the light source were also investigated with the apparatus. The neon fluorescent tube of the meteor spectrosensitometer was used as the light source to determine these differences. A diffraction grating was mounted in front of the camera objective. A line diffraction spectrogram was photographed on the film as the camera was rotated in the vertical plane. Measurements of the individual spectral lines showed the field error had the same behavior for the various wavelengths.

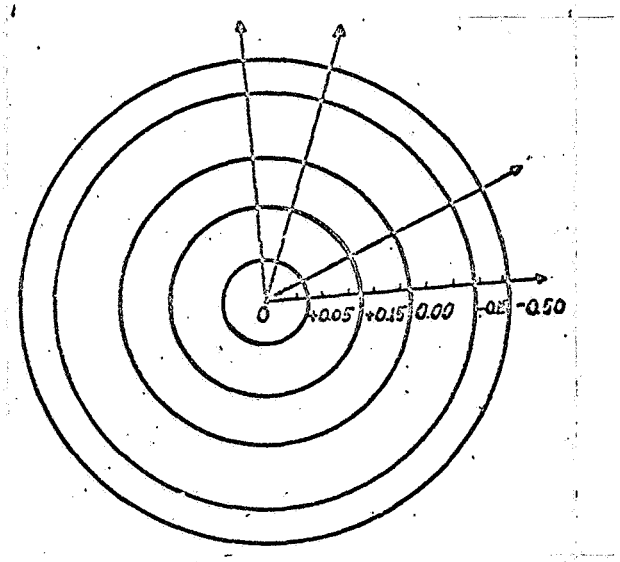

Figure 1. Photometric Field Error of one NAFA-3S/25 Camera. The Numbers Represent the Optical Density of the Designated Region. The Optical Density is Assumed Equal to Zero at the Optical Center.

As shown in [2], star images can be used to construct the characteristic curve for the purpose of determining the spectral intensities of a satellite. The stellar magnitudes of a certain spectral region were extracted from H. Johnson's catalog [3] and were corrected for atmosphere absorption and reduction to the

equator. The optical densities were corrected in accordance with the camera field error data.

Thus, it was found to be possible to determine the spectral intensity of a satellite and of any star. The photographic spectrogram of the star α Pegasus was found on a test frame near a satellite image. The energy distribution in the spectrum of this star in absolute units is given in A. V. Kharitonov's paper [4]. By comparing the logarithms of the star intensities, determined in our photometric system, with the logarithms of the absolute measurements, one can obtain a curve expressing the total influence of the spectral properties of the photographic system (atmosphere, optics, film). We assume that the energy distribution in the satellite spectrum matches the continuous solar spectrum [4]. By comparing the logarithms of the intensity in the "Echo-2" spectrum with the solar energy distribution, one can also obtain a curve that describes the spectral properties of the system.

The spectral sensitivity curve of the system, obtained from the stellar intensities, is shown by the dotted curve in Fig. 2; the dashed curve is obtained from the ISZ (artificial earth satellite) data.

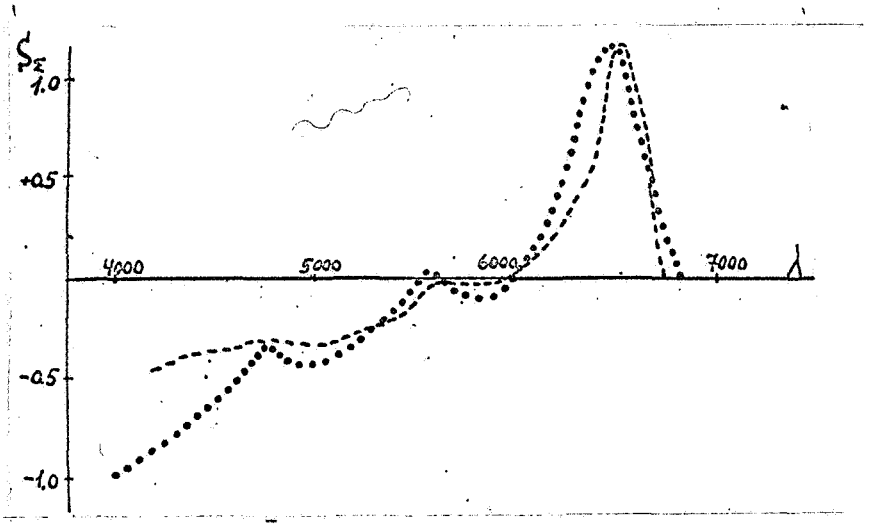

Figure 2. Curves Showing Spectral Sensitivity of the System Used for Satellite Photography.

The difference in the curves at the violet end of the spectrum is apparently caused by a difference in the photometric scales. The excellent agreement of the curves confirms the assumption that the intensity distribution in the spectrum of the "Echo-2" satellite is quite accurate represented by the energy distribution in the continuous solar spectrum. /14

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